Ground investigation for apartment development.

New Bedford offshore wind farm.

Geothermal project in Glasgow.

ROBERTSON GEO

Unlocking Your GeoData

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GLOBAL GEODATA NEWS

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Meeting the necessary logging

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Calibration Counts...
Why probe calibration is vital for conformance in the slimhole borehole logging industry

1,365m underground in the world's largest iron ore mine

THE KIRUNA MINE is the largest and most modern underground iron ore mine in the world.

The mine is located in Kiruna in Norrbotten County, Lapland, Sweden. The mine which is owned by Luossavaara-Kiirunavaara AB (LKAB), a large Swedish mining company, has an annual production capacity of over 26 million tonnes of iron ore.

The Kiruna mine has an ore body which is four kilometres (2.5 miles) long, 80 metres (260 ft) to 120 metres (390 ft) thick and reaching a depth of up to two kilometres (1.2 miles). Since mining began at the site in 1898, the mine has produced over 950 million tonnes of ore.

Aaron Jones, Senior Logging Engineer reflects on a project at the Kiruna Mine in Sweden.

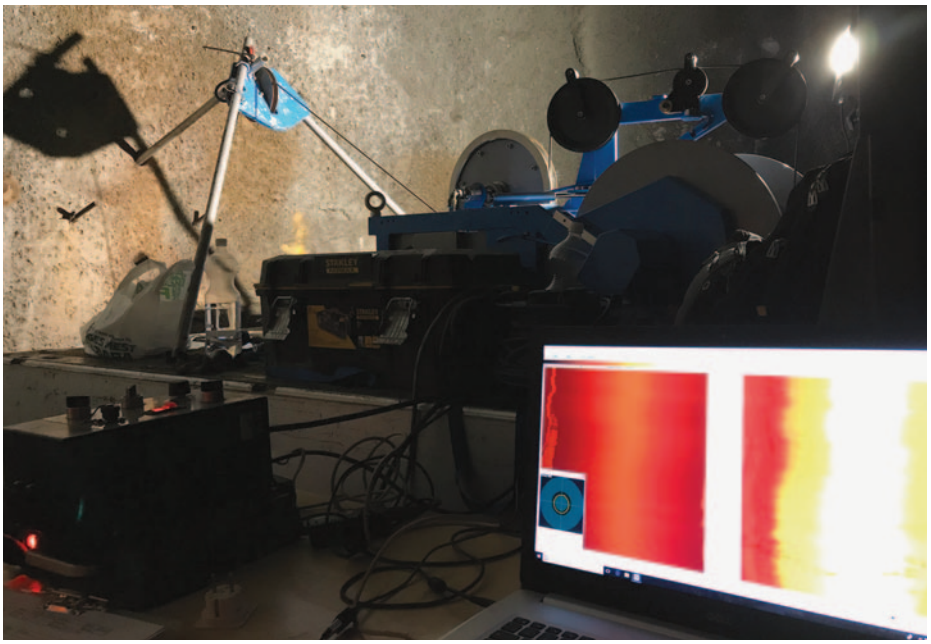
AS THE ROBERTSON Geo engineers arrived in Kiruna the early snows had already arrived and the temperature was touching -15°C. The logging team arrived with mixed emotions, an appreciation of the location being within the Arctic Circle with the stunning scenery of Sweden to admire and the possibility of seeing the Northern Lights; but also some anxiety of the location of the boreholes being some 1,365m below surface, not the most common of places we carry out logging.

Once the shipped equipment arrived we loaded our truck and headed to the mine. The journey down to the borehole location was not one we will forget anytime soon, 30 minutes after entering the mine and 16km later we arrive at our first bore hole 1,365m below surface. The anxiety really started to bite halfway down and after 15 mins driving steeply spiralling down to what felt like the centre of the earth, the LKAB representative who was with us calmly informed us we were half way. We eventually reached the location after what felt like four days driving (it was only 30 minutes) and after five minutes out of the truck we soon forgot how far down we were and got cracking with the job in hand. The boreholes were inclined between 10°-40° from vertical and down to depths of 500m from tunnel level.

High Resolution Optical and Acoustic Televiewers, Magnetic Susceptibility and Resistivity probes were deployed via a 2,000m winch with the data capture using the Robertson Geo Micrologger2, the surface interface system for handling logging data acquisition, together with Winlogger, the MS Windows based operating system.

The Magnetic Susceptibility gave very good and clear results of the iron deposits within the boreholes, as did the Resistivity and Televiewers with the Acoustic giving really excellent images of fractures within the boreholes.

As each day went by the journey in and out of the mine became second nature and we understood how the LKAB representative could be so calm on the drive in on our first day. I must admit I did feel a sense of relief everyday on exiting the mine and seeing daylight again.



"The journey down to the borehole location was not one we will forget anytime soon..."

Experience

...is when it matters

Borehole logging has its ups and downs, good days and bad days - but it's the bad days that test the quality of a service, and can easily differentiate the best from the rest.

AT ROBERTSON GEO we pride ourselves on the service, having our client's complete satisfaction as our aim, whether it be mobilising engineers and equipment within a couple of hours to the other side of the world or carrying portable equipment for miles over hills and through peat bogs in the middle of winter, we go the extra mile.

Recently we encountered a problem whilst running a log with 1/4" cable passing through a stuffing box. Our probe was down at 907m in a borehole under 400 millibars of suction when we spotted that the cable had began to "bird nest" above the stuffing box. (A "bird nest" is when the outer strands on the braided wireline come away from the inner ones).

Within an hour Robertson Geo had another team on the road with a second system to finish the logging and to aid in the recovery of the probe and cable if needed. Our experienced onsite engineers remained calm and having seen it all before, they were able to recover the 907m of cable and probe from the borehole within a couple of hours and before the second system arrived.

Top: Image showing the cable damage "bird nest".
Right: Second crew arrives on site within hours.

GeoInfo

Why probe calibration is so vital and how Robertson Geo maintains a framework for conformance unparalleled in the slim borehole logging industry.

Calibration COUNTS

Graham Comber
Logging Services Manager, Robertson Geo

Calibration COUNTS

From its inception in 1979 the goal of Robertson Geo has been to develop its reputation as a world leading manufacturer and service provider for slimline geophysical probes and associated systems. To achieve this, the need for a comprehensive conformance system for all probes and associated equipment was essential to provide qualitative log data that is traceable to known industry references.

In order to satisfy this, a test borehole facility was established at the Deganwy manufacturing site with the drilling and casing of a 100m borehole. This facility remains an integral part of the system to ensure conformance of all probes that are sold, rented or used by Robertson Geo Service logging teams.

The logs from many thousands of probes in this borehole all contribute toward guaranteeing the accuracy and repeatability of Robertson Geo data.

Compliance is the key to success

Robertson Geo's tool calibration and ISO 9001-2015 procedures provide reassurance that data acquisition complies with the various mandatory requirements for the classification of Mineral Exploration Results, Mineral Resources and Ore Reserves. This level of confidence is critical in defining geological knowledge and technical/economic parameters for use in Public Reports, including the JORC, CIM, UNFC, CRIRSCO, PERC, SAMREC, SME and MRC International standards. Robertson Geo is licensed to factory test and calibrate its nuclear tools with corresponding radioactive sources prior to shipping. ***Unless this is achieved, logging results cannot meet the necessary compliance standards and log data cannot be used for qualitative measurement or calculations.***

Definition of Calibration

Calibration in its strictest form means "comparison to known standards". In practical terms this needs to be extended to cover "measurement uncertainty" and "traceability". Metrology is the science of measurement. The fundamental objective of metrology is to ensure traceability as an essential precondition for the comparison of measurement results.

Conformance Framework and ISO 9001

Robertson Geo is the only slimline probe manufacturer/logging services provider with a QMS certified to ISO 9001:2015. This system dictates that the calibration/conformance process must be formalised, periodic and documented.

A fundamental requirement of the design process for all new probes is that they hold calibration over a period within tolerance. To maintain this throughout the product lifecycle involves control of supply chain conformance, manufacturing processes, testing, repairs and a feedback system to identify problems and modification requirements.

Geophysical logging is essentially a data business. The aim of the calibration/conformance system is to "maintain quality of measurement" for all users of Robertson Geo equipment, including ourselves. In industrial sectors where compliance and traceability are fundamental, all probes come with a certificate of conformity (*see Fig. 1*), and a probe maintenance service is available to verify functionality and calibration.

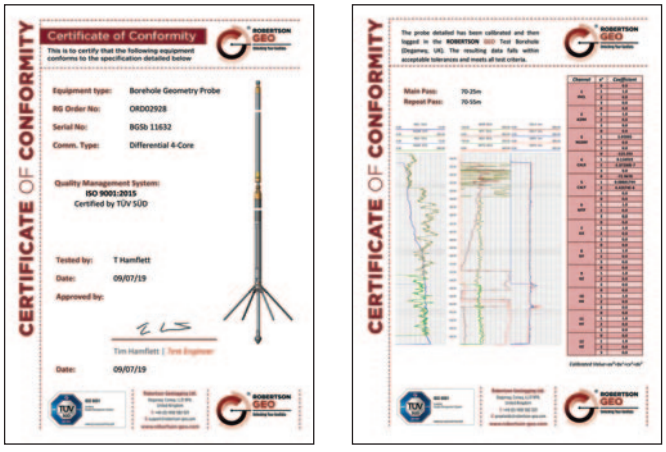


Fig. 1 - Example Conformance Certificate.

Risk Mitigation

The management of risk is an essential component for all civil engineering projects and the responsible engineers need to have confidence in the ground investigation (GI) data they are provided with. Budget constraints can mean that the GI scope is limited and therefore maximum value needs to be extracted

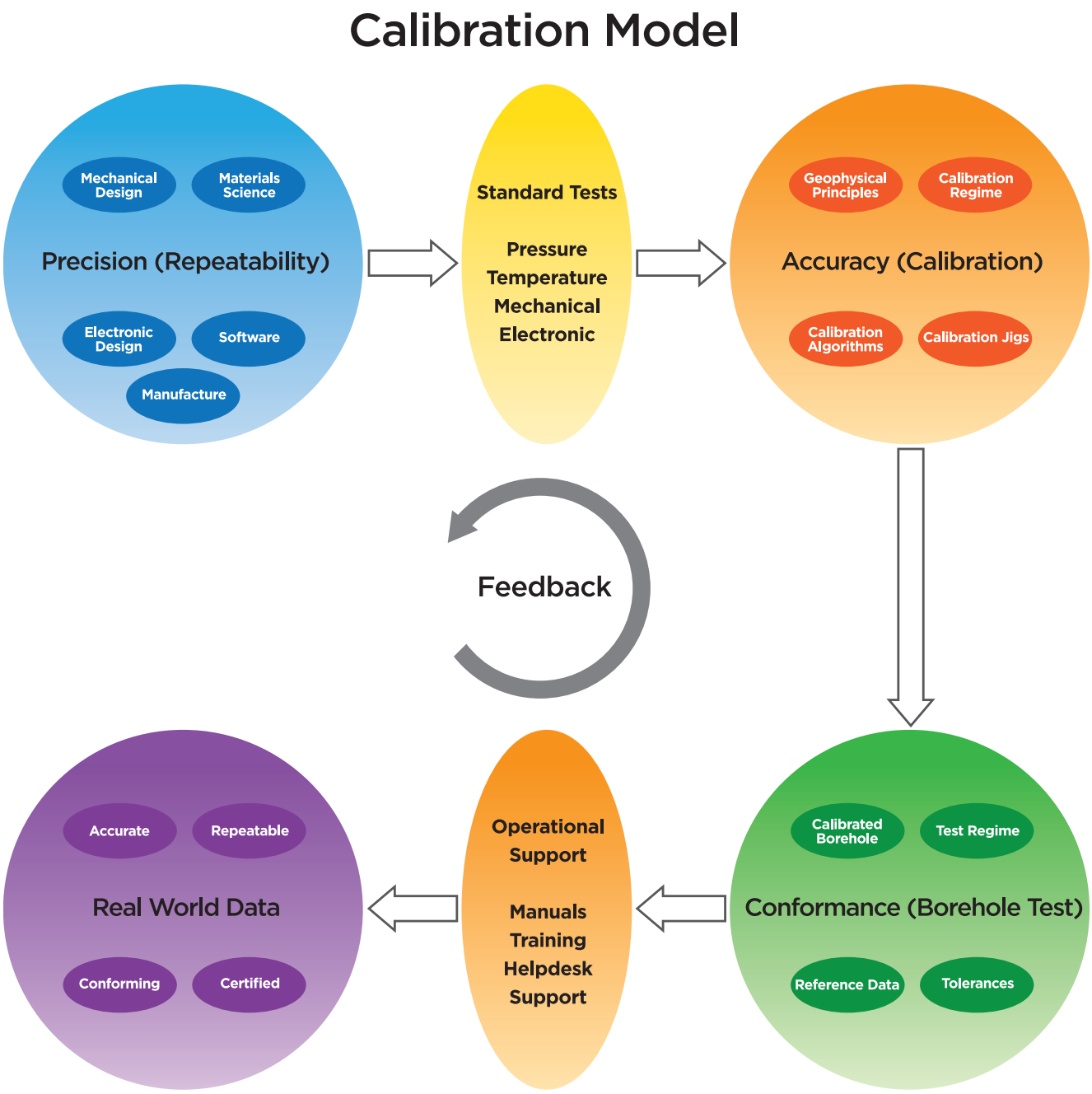


Fig. 2 – Robertson Geo Calibration Model.

from what data is gathered. Geophysical logging produces in-situ data throughout the extent of drilled boreholes, filling in potential gaps due to, for example; poor core recovery or CPT refusal. The risks associated with the ground and the groundwater can be unique to a site, especially in the UK where the diversity of geological conditions is high and accurate data is vital to mitigate these risks.

The implications of inadequate site investigation can be increased costs and delays, over-engineered designs, or in the worst cases - disasters such as structural failures. The financial and possibly legal penalties from post project forensics on failed projects means that all GI providers need to remove as much uncertainty as possible in the quality of data. This article will demonstrate how committed Robertson Geo are about providing accurate, repeatable data from all their probes, thereby increasing confidence in data quality.

It is vital to understand the subsurface characteristics for geotechnical applications and civil engineering projects. Robertson Geo is a specialist and a very experienced international provider of wireline logging data acquisition and interpretation for these industries, with its technologies in worldwide use every day.

The Calibration Model (*See Fig. 2*)

As designers and manufactures of all equipment supplied, the design of appropriate calibration regimes remains our responsibility. The underlying tenet we use is that all theoretical calibration models must also pass scrutiny in our test borehole.

This means that accuracy and repeatability in a real-world situation are a prerequisite. An adjunct to this is to provide training ensuring that the operators of the equipment are also fully competent.

The route to fully calibrated data in the real world starts with the design of the probes. To develop probes capable of high precision/repeatability the appropriate design of sensors, mechanical components, electronic systems, materials and software is necessary. Once the design is established the manufacturing process must also be fully controlled. This involves control of build processes, suppliers, components, batch testing, responding to feedback and implementing change requests. Traceability is also key and, at Robertson Geo, conformance to ISO 9001:2015 is maintained throughout.

Whether at the design stage or in the production stage the probes need to be capable of holding their precision throughout the most extreme conditions dictated by the probe specification. This testing includes electronic systems, mechanical components and the application of cycles of temperature and pressure on the complete probe up to the specification limits. The latter cycles are achieved using sophisticated, calibrated pressure/temperature vessels based at Deganwy.

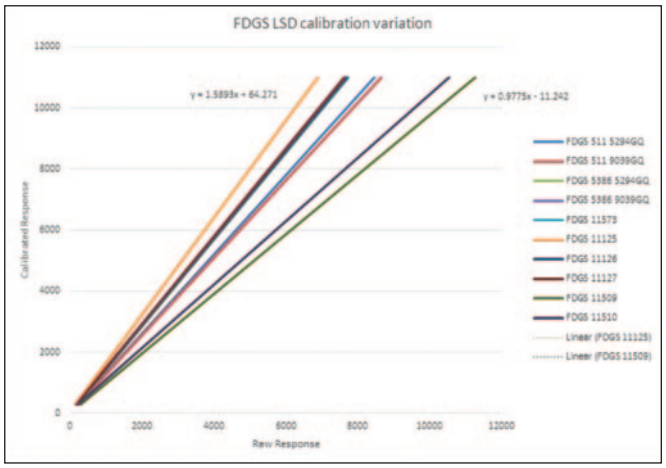


Fig.3 - Calibration curve variation from same spec. probes and sources showing importance of "matched pair" calibrations.

Once a probe is designed and manufactured to be capable of the requisite precision it now must have a suitable calibration applied to it. Based on an understanding of the underlying geophysical principles a calibration regime is designed. In most cases this involves the application of fixed points and a best fit polynomial curve between the points. For two fixed points the curve is linear, for three points quadratic and four is cubic. The fixed points need to be established, often in calibration jigs (which are themselves calibrated to known industry references such as the Adelaide DWLBC calibration pits or ELGI, Hungary) or as easily obtainable standards such as free air or water. Counts from the probe are then taken for each fixed point and a best fit curve applied. The resulting coefficients are placed in a standard calibration file which the software can subsequently utilise. Often there will also be constraints that need to be observed during the calibration process such as separation from ferro-magnetic materials or temperature stabilisation time. For probes detecting radioactivity, a random process, an understanding of the statistical nature of the system and the effect of low count rates must also be considered. For density and neutron probes which require an attached radioactive source, the calibration coefficients obtained are only applicable for the specific match of probe and source (*See Fig. 3*).

To ensure that the calibration regime is appropriate and accurate, all probes are subject to a borehole test. This is undertaken for all new or repaired probes and also for our in-house logging services teams at regular intervals. Calibrated records for the test borehole have been determined using established industry references at ELGI Hungary and the DWLBC calibration pits (API) in Adelaide, Australia to provide the reference models. Characteristic log curves for all probes have been built up from thousands of logs taken over more than 40 years. When the calibrated probe under test has produced its specific curves, they are laid over the reference logs to ensure that they are within acceptable tolerance. Any non-conforming probe will be rejected and subjected to remedial action and then re-tested.

To complete the overall process, Robertson Geo make every effort to ensure that the probe is used appropriately in the field. Manuals are provided with all probes and are available on the company website. A helpdesk facility is also provided whereby customer problems and data can be analysed when queries arise. Comprehensive training is available on all probes for our in-house staff, rental customers and sales customers alike.

Conclusion

It is imperative that any logging system that acquires geophysical log data which will be used for quantitative purposes, whether that be for mining resource estimation or civil engineering design, is supported by a traceable and verifiable calibration regime.

Robertson Geo comprehensively calibrates all its logging systems and uniquely uses an on-site borehole for verifying performance at its Deganwy test well and calibration facility, inspiring confidence that all data acquired is calibrated, traceable and verified to known industry standards.

Only when log data can be demonstrated as conforming to an established calibration regime can it be relied upon for design and engineering purposes. Furthermore, the use of traceable log data significantly reduces the project risk for the end user of such information and provides it with a reliable geology model that informs the project design and decision-making processes.

The Horizon Geosciences ship 'Horizon Geobay'.

New Bedford Massachusetts Wind Farm

First large-scale offshore wind energy project in the USA

ROBERTSON GEO IS contracted by Horizon Geosciences for this important project managed by Vineyard Wind LLC.

The objective is to build the first large-scale offshore wind energy project in the USA. The project is divided into two sections, with Vineyard Wind 1 functioning at a capacity of 800MW, enough to generate sufficient energy for one million homes. Vineyard Wind 2, further south is proposed to generate 400MW with the potential to develop a further 800MW at this location.

The Robertson Geo PS Logger probe has been used for characterisation of the marine subsurface along with a 2,000m Marine Winch, Micrologger2 (the surface interface system for data acquisition) and winch controller system. The equipment was deployed from the Horizon Geosciences drill ship, the 'Horizon Geobay'; a total of six boreholes were completed in May/June 2018, with a further 10 completed in July/August 2019, with depths ranging from 50m to 70m.

Passive Acoustic Monitoring (PAM) in combination with 24/7 visual monitoring for marine mammals is ongoing throughout the project to minimise the disturbance of ongoing drilling and surveying activities on the surrounding marine species. This is especially important off the coast of New Bedford as it is nicknamed 'The Whaling City' as it was one of the most important whaling ports in the world during the 19th century.

THE ROBERTSON GEO 2,000m Marine Winch was securely welded into a steel frame at the beginning of the project. This frame was then strapped to railing on the drill deck when not in use.

Before PS Logging of each borehole, the frame and winch unit is systematically lifted and secured onto the rooster box, and the cable head released down to the drill deck to connect to the probe.

After logging is completed, the frame and winch unit is then lowered back down to the drill deck, where it is secured until the next PS Logging opportunity.

Work begins on 232 apartment development in Salford UK

Above: With Robertson Geo having completed their ground investigation, piling works start on the first apartment block at the Worrall Street site.

Left: Artist impression of how the apartments will look.

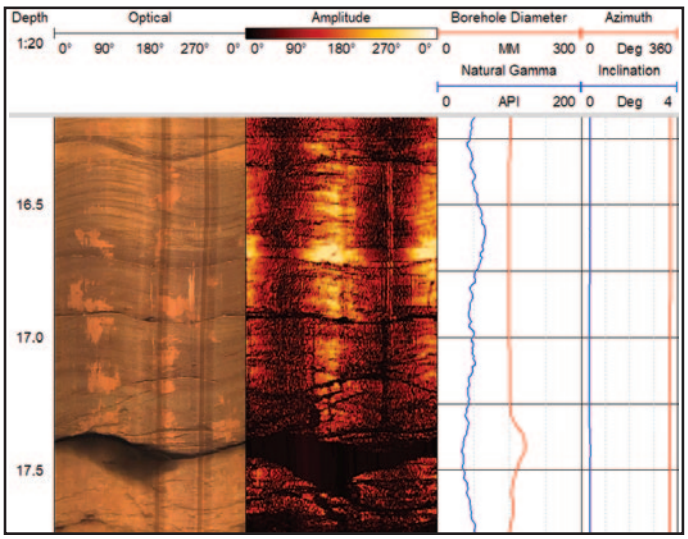
DEVELOPER FORSHAW AND contractor CPUK have begun piling works at an 86 apartment, £12m scheme at Worrall Street in Salford.

CPUK was first revealed as preferred bidder for the project in January this year and confirmed as main contractor in July, and with remediation now complete, the company has taken possession of the site and begun piling, before starting concrete pours in the coming weeks.

The contractor will deliver a mix of one, two and three-bedroom apartments along with a gym and residents' lounge. Stretching to nine storeys at its highest point the block is one of three proposed as part of a wider 232 apartment development.

Robertson Geo recently carried out the pre-piling ground investigation for the construction of the new riverside development. Probes deployed included the High Resolution Optical Televiewer, High Resolution Acoustic Televiewer and 3-Arm Caliper. The data retrieved from the three probes was required for the identification of fractures or voids in the rock subsurface of the site.

Probes were deployed from a 2,000m four core winch from a Robertson Geo purpose-built logging vehicle. Use of the roof mounted boom and tripod assembly allowed the logging of multiple boreholes from one central location, reducing onsite rig up and down time.



Left to right: Galang Yogasatria, Yoggie Surya Pradana, Rizky Febriansyah, Mangisi Haryanto Parapat and Tim Hamflett.

Robertson Geo customer Taka Hydrocore of Indonesia recently sent across a team of Engineers for PS Logger training at our Deganwy manufacturing facility.

Other than specific product training; we also offer more comprehensive training courses at Deganwy. Operational training is for winch use, probe deployment, logging techniques, data capture, and equipment maintenance and troubleshooting. These training schedules are flexible (from one to five days) and customised, depending on the experience levels and focus of attendees.

Training certificates and electronic copies of manuals and test data are provided and whilst it is preferable that training is undertaken at the Deganwy calibration and test well facility, training can also be conducted at the customers' site, including international locations.

Contact us for a customised or operational training quotation.

Our impressive safety record of over 40 years

Safety and Quality Assurance are of prime importance in achieving a valid approach to field investigations and delivery of client requirements. Robertson Geo has demonstrated an impressive safety record of over forty years of logging services, based on the principles outlined in the International Association of Geophysical Contractors Land Geophysical Safety Manual. These satisfy the requirements for its entire field services department, design, manufacturing and sales activities.

Introducing our new Safety Icon.

Serge's workshop tips

Spheerol SX2

This grease is use for marine applications and provides protection from salt corrosion and has been seen to provide protection against electrical pitting.

- *Strong adhesion to metal surfaces*
- *High resistance to seawater and fresh water wash out*
- *Wide operating temperature range (-20°C to 140°C)*
- *Long term stability with no premature hardening*
- *Excellent corrosion protection*
- *Calcium Sulphonate complex based*
- *Contains no solvents, metals or other harmful constituents*

This grease is used in the bearings on our marine winches and is also used inside the cable head instead of DC4 silicone.

Copper anti-seize compound

Anytime similar metals are moving and are touching with any type of friction, some metals are known to cold weld and galling can occur and will then be scrap. The best way to avoid this is to apply copper anti-seize compound to the metallically similar threads. This will help not only with assembly but then also with disassembly especially when an assembly has been exposed to wet and corrosive surroundings.

This is used on body tubes and probe heads as they are mostly a similar metal.

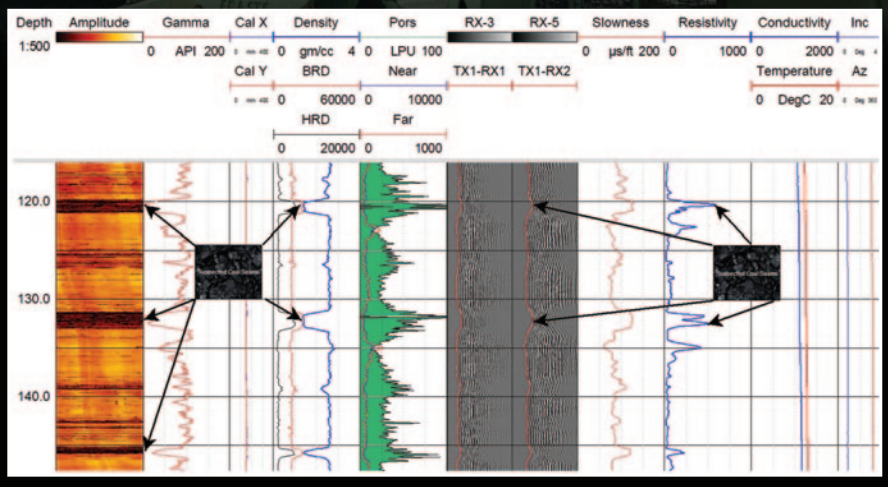
UK GeoEnergy Observatory for Glasgow

Geothermal project

AT DECEMBER 2018 the first borehole had been logged by Robertson Geo at the UK GeoEnergy Observatory for Glasgow, allowing scientists to 'see' underground at the geothermal energy research site. A comprehensive suite of eight probes was used for subsurface data acquisition from this initial borehole of 200m

The ongoing project is for a 15 month period; more boreholes of various depths have been drilled and logged during 2019. The objective is to enable research into Glasgow's geology, its underground water systems and the potential for heat from the water in the city's disused coal mines.

One of the aims of the project is to find out if there is a long-term sustainable mine water resource that could provide a low-cost, low-carbon heat source for homes and businesses. Measurements will be taken from the boreholes, such as temperature, water movement and water chemistry.



Composite log data showing suspected coal seams.

ROBERTSON GEO
Unlocking Your GeoData

40 YEARS 1979 - 2019

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